Small Business Innovation Research/Small Business Tech Transfer

More Ductile Bulk Tungsten, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

This SBIR Phase I effort will develop and demonstrate a novel manufacturing process based on severe plastic deformation (SPD) to refine and enhance the microstructure-properties of bulk tungsten. Tungsten, with its many unique characteristics, plays an important role in nuclear reactors including for the nuclear thermal propulsion engine. The refractory metal, however, still has a number of shortcomings which still need to be addressed. These include a high ductile-to-brittle transition temperature, low ductility and poor fracture toughness, low machinability and fabricability, low-temperature brittleness, radiation-induced brittleness, and a relatively low recrystallization (RX) temperature compared to its operation temperature. The use of W above its RX temperature interminably can be unsafe because its mechanical properties decrease in such an environment. Low-temperature brittleness also imposes restrictions on the application of W as a structural material. And, given its high hardness, high brittleness, and poor machinability, W parts can be very costly and time-consuming to manufacture. Past efforts to increase the ductility of W were primarily directed on alloying, grain refinement, extreme working, area reductions, impurity reductions, and heat treatments. While ductile W currently exists in wire form (e.g., filaments) through extensive working and area reduction, this approach is clearly not practical for applications where bulk size parts are needed.

Anticipated Benefits

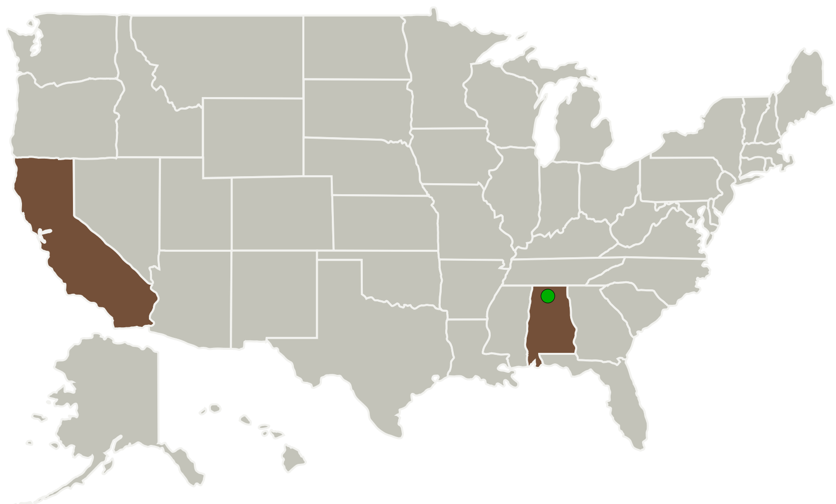
High temperature shielding structures and hot gas path nozzles and thrusters for diverse spacecraft and rocket propulsion systems including the nuclear thermal propulsion engines will benefit from a more ductile bulk tungsten material. Other applications include hot structures and heat shields for reusable launch vehicles and/or aircraft engines.

High temperature shielding structures and hot gas path nozzles and thrusters for diverse commercial and military spacecraft and rocket propulsion systems will benefit from this material. Other applications includes structures and components for reusable launch vehicles, nuclear reactors, gas turbines (both aircraft and industrial), armaments and munitions, and chemical process equipment. Even more applications will open up if tungsten's low ductility can be improved.

More Ductile Bulk Tungsten, Phase I

Table of Contents

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Transition45 Technologies, Inc.	Lead Organization	Industry Small Disadvantaged Business (SDB)	Orange, California
Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations	
Alabama	California

Project Transitions

July 2018: Project Start

February 2019: Closed out

Closeout Documentation:
- Final Summary Chart*(https://techport.nasa.gov/file/141181)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Transition45 Technologies, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

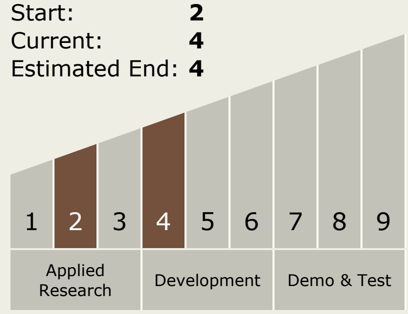
Carlos Torrez

Principal Investigator:

Edward Y Chen

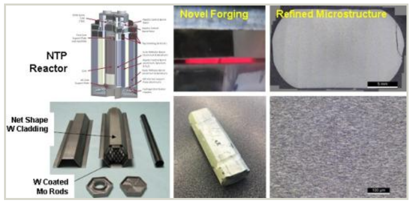
Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



Images

Briefing Chart Image
More Ductile Bulk Tungsten, Phase I
(https://techport.nasa.gov/image/128939)



Final Summary Chart Image
More Ductile Bulk Tungsten, Phase I
(https://techport.nasa.gov/image/127773)

Technology Areas

Primary:

- TX01 Propulsion Systems
  └ TX01.4 Advanced Propulsion
    └ TX01.4.3 Nuclear Thermal Propulsion

Target Destinations

Earth, Mars, Others Inside the Solar System